

Locating Performance Bottlenecks in Home Networks

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Problem: Service Calls are Costly

- The cost of a service call to an ISP is \$9–25
 - “Truck rolls” cost considerably more
- As many as 75% of these calls are caused by problems *within the home network*
- **Can we help the user help themselves?**
 - **How to determine whether the problem is the ISP or the home wireless network?**

Causes of Problems Inside the Home

- Bad wireless connection
- Poor placement of access point
- Interference from other access points and devices
- Contention from other devices
- Cross-traffic on the wireless network
- Non-Wifi interference (baby monitors, etc.)

Challenges

- Active measurements are invasive, inaccurate
 - Wireless performance is too variable
 - The probe traffic itself disrupts the wireless network (interference, contention)
- Conditions are dynamic
- Performance characteristics depend on vantage point

Approach: Deploy on the Gateway



- Advantages
 - “Demarcation point” between the home wireless network and the access link
 - Can observe all traffic passing through the router
- Disadvantages
 - Limited resources for traffic capture and analysis
 - Deployment is more difficult

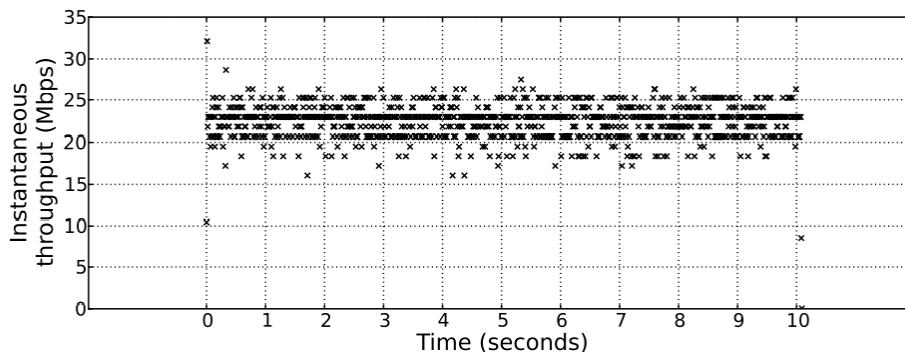
General Approach

1. Determine whether the access link is the bottleneck
2. Look for pathologies in the wireless network
3. Look for pathologies in the wide area

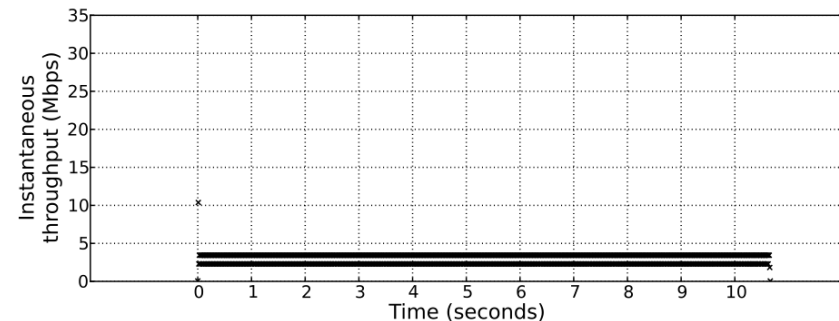
Identifying Wireless Bottlenecks

- Measure instantaneous throughput
 - When wireless link is the bottleneck, throughput is much more variable
 - Caused by variability in packet interarrival times
- Measure coefficient of variation of packet interarrival time

Wireless Link Bottleneck



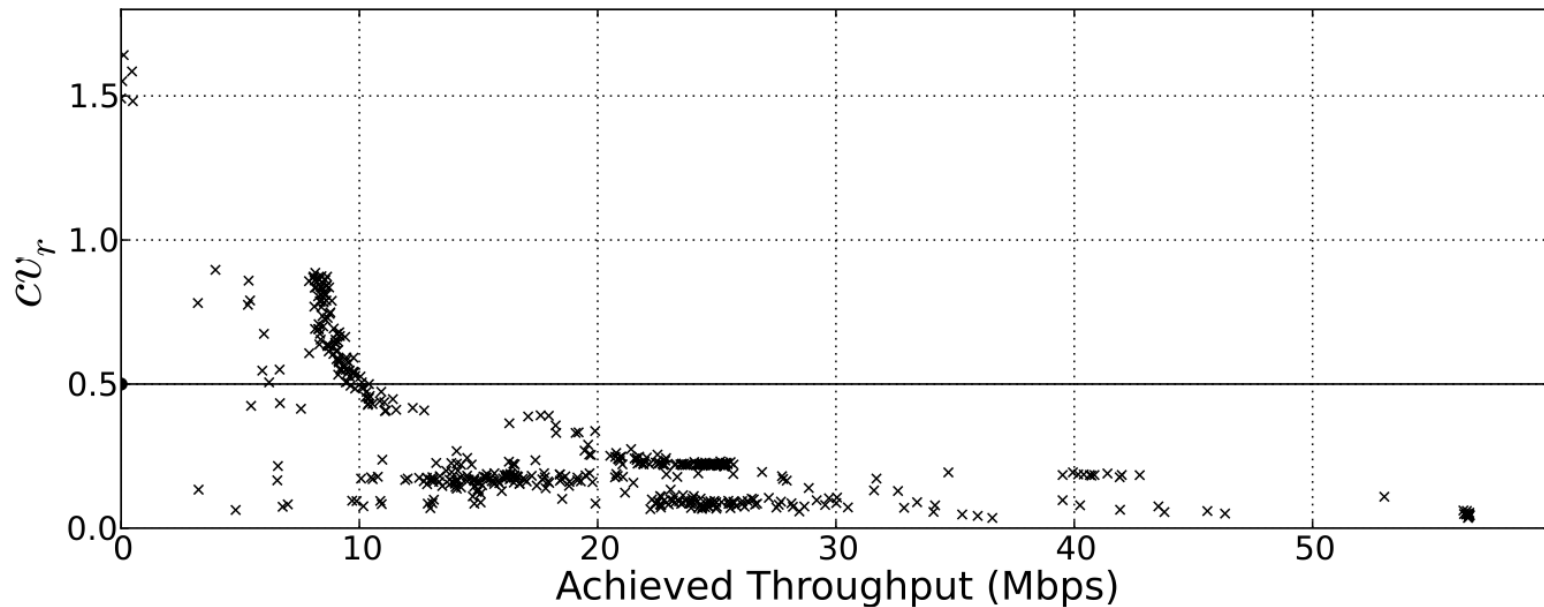
Access Link Bottleneck



Accuracy is near 100% for a wide range of values, across many network types.

Look for Pathologies in the Wireless

- High bitrate variation often indicates poor wireless channel quality

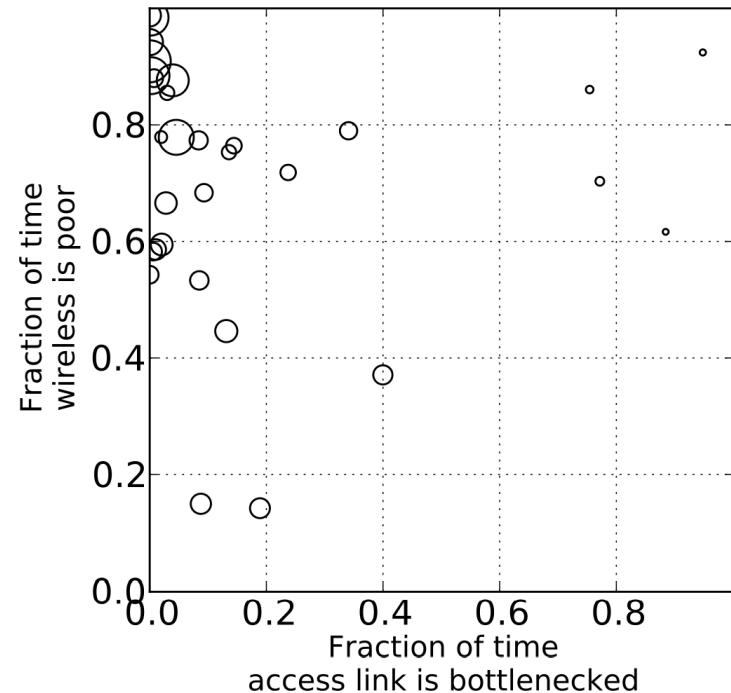
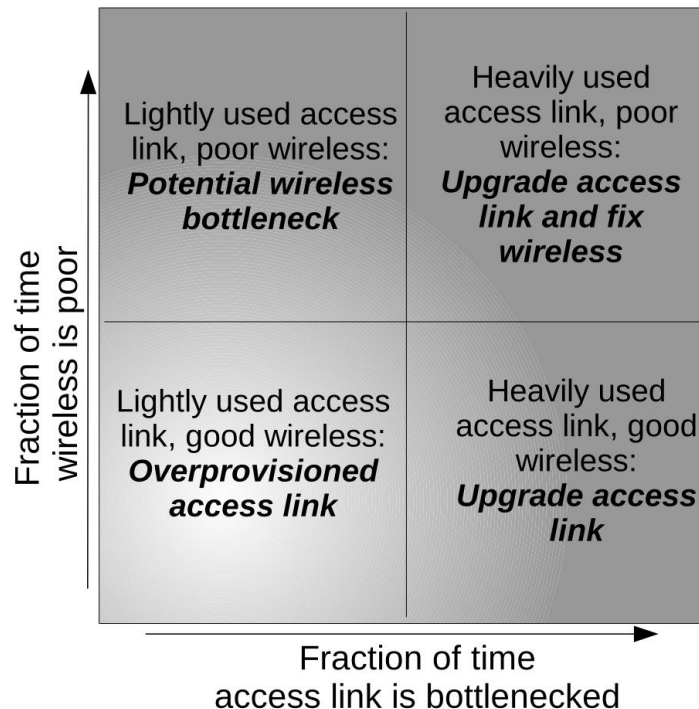


Other Wireless Pathologies

- Low normalized average bitrate
- Higher retransmission rate
- High TCP Round Trip time between client and access point
 - Indicates possible contention in wireless

Main Takeaway

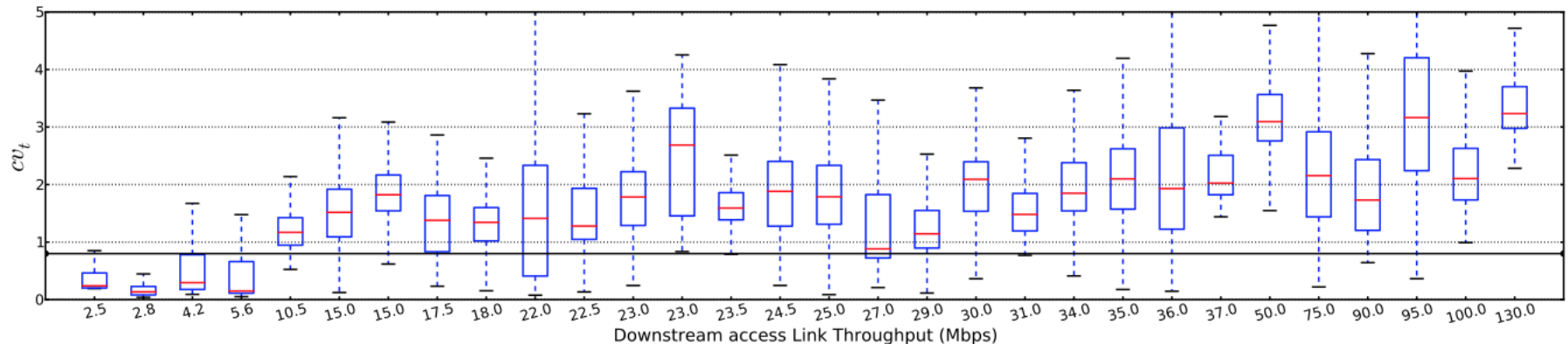
Once downstream throughput exceeds about 10 Mbps, bottlenecks are typically inside the home.



Exploring Performance Across Homes

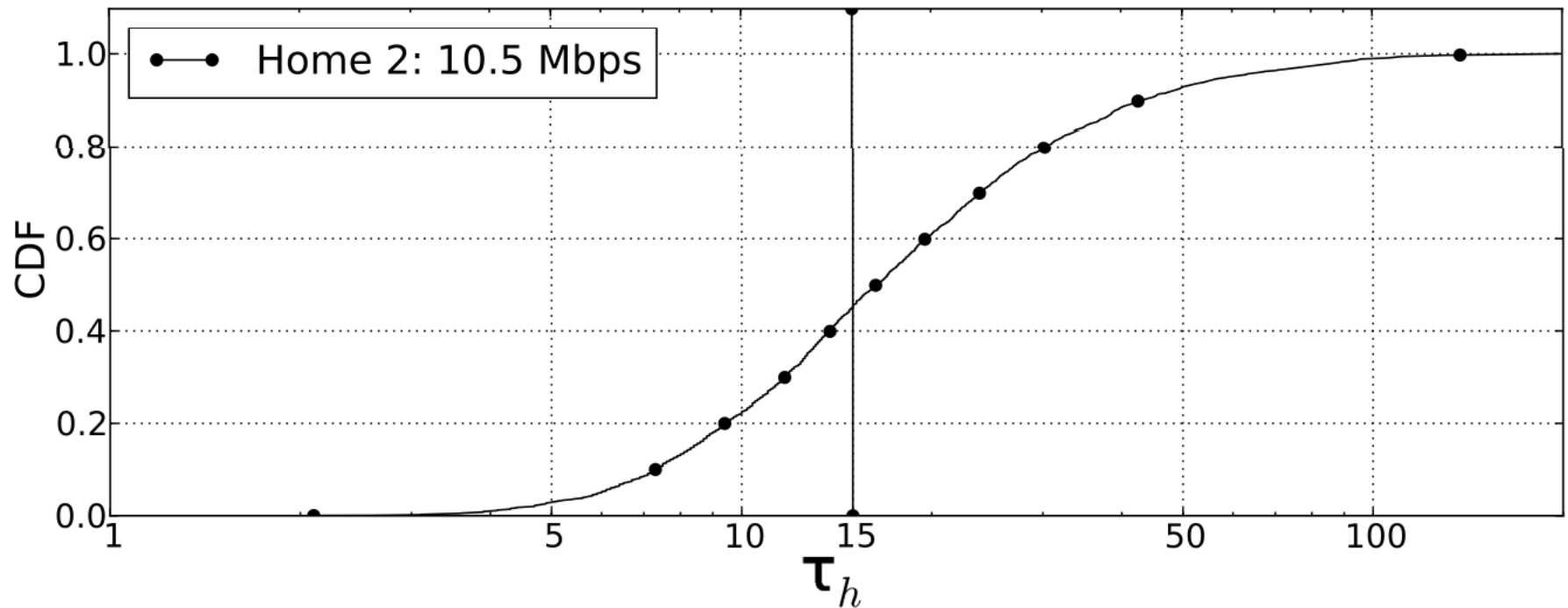
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Coefficient of variation in packet interarrival times across each home, as a function of throughput. Higher values mean wireless bottleneck.



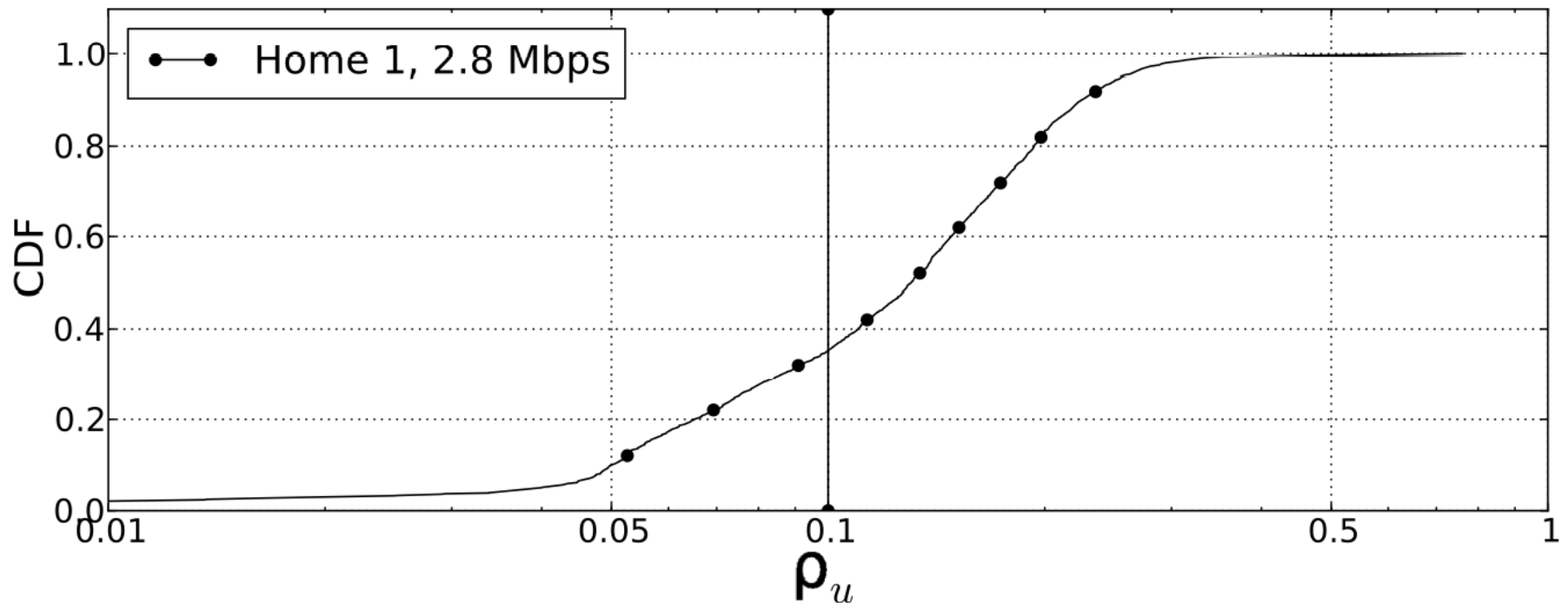
Case Study: High In-Home Latency

RTT between the client and the AP can be high.



Case Study: Retransmissions

Excessive retransmissions can occur, as well.



Deployment Status and Next Steps

- Deployed on 80+ routers across the BISmark testbed
- Currently only runs in “sampled” mode
 - Collects packet traces for 15 seconds every 5 minutes
 - Uploads to server for offline analysis
- Online mode is currently being developed
- **Possible next steps**
 - Implement online version
 - More statistical rigor behind some of the thresholds

Conclusion

- Home network users experience many performance problems in home networks
 - Many of these problems are with the home wireless network, *not with the ISP*
- We have built and deployed an open source, router-based tool to distinguish access link bottlenecks from wireless bottlenecks
 - Ultimately, hopefully reduced service calls